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Status of the
Peregrine Falcon
(Falco peregrinus anatum)
in Alberta


Petra Rowell
David P. Stepnisky



Alberta Wildlife Status Report No. 8



Alberta
ENVIRONMENTAL PROTECTION



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**Petra Rowell
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PREFACE

Every five years, the Wildlife Management Division of Alberta Natural Resources Service reviews the status of wildlife species in Alberta. These overviews, which have been conducted in 1991 and 1996, assign individual species to "color" lists which reflect the perceived level of risk to populations which occur in the province. Such designations are determined from extensive consultations with professional and amateur biologists, and from a variety of readily-available sources of population data. A primary objective of these reviews is to identify species which may be considered for more detailed status determinations.

The Alberta Wildlife Status Report Series is an extension of the 1996 *Status of Alberta Wildlife* review process, and provides comprehensive current summaries of the biological status of selected wildlife species in Alberta. Priority is given to species that are potentially at risk in the province (Red or Blue listed), that are of uncertain status (Status Undetermined), or which are considered to be at risk at a national level by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC).

Reports in this series are published and distributed by the Wildlife Management Division of Alberta Environmental Protection, and are intended to provide detailed and up-to-date information which will be useful to resource professionals for managing populations of species and their habitats in the province. The reports are also designed to provide current information which will assist the proposed Alberta Endangered Species Conservation Committee to identify species that may be formally designated as endangered or threatened under the Alberta Wildlife Act. To achieve these goals, the reports have been authored and/or reviewed by individuals with unique local expertise in the biology and management of each species.

EXECUTIVE SUMMARY

Three subspecies of Peregrine Falcon (Falco peregrinus) occur in Canada; only the anatum subspecies breeds in Alberta. Prior to the 1970s, this bird could be found nesting on the banks of every major river system in the province. Unfortunately, the world-wide, indiscriminate use of organochlorine pesticides such as DDT after World War II severely affected peregrine breeding success. By the mid-1960s, Peregrine Falcon populations had crashed both in North America and elsewhere. In 1970, only three pairs could be located in Alberta.

The anatum Peregrine Falcon is currently listed as an “endangered” (sub)species, both nationally by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and provincially under the Alberta Wildlife Act. This subspecies is also listed as “endangered” in the United States. However, a formal proposal has been made to de-list the anatum peregrine in that country, and the status of the anatum subspecies is currently under review in Canada.

With declining use of persistent organochlorine pesticides, and following a number of intensive management programs, Peregrine Falcons have made a strong recovery in many parts of the world. The recovery in Alberta has been significant over the past five years with approximately 34 known nesting pairs recorded in the province in 1997. Although a number of management goals have been achieved, some individuals are still affected by pesticide residues and some sub-populations may still be hampered by low productivity. Moreover, a large proportion of current populations, particularly in southern Alberta, are comprised of captive-raised birds that have been supplemented to the population.

Although Peregrine Falcon populations appear to be recovering, intensive management programs, such as captive rearing, fostering of young to wild nests, and the use of hack releases, are being phased out in Alberta. It is therefore vital to maintain monitoring programs to ensure that the recovery will continue in the future, and that local populations are self-sustaining.

ACKNOWLEDGEMENTS

A status review of the Peregrine Falcon in Alberta in 1997 is possible only because of the monumental effort of a handful of individuals whose work spanned three decades saving this endangered species. Richard Fyfe, Harry Armbruster, Ursula Banasch, Geoff Holroyd, Helen Trefry, and Phil Trefry (Canadian Wildlife Service) were instrumental in the success of the Wainwright raptor breeding facility that provided young peregrines for release across Canada. In Alberta, Gary Erickson, Dave Moore, Wayne Nelson, Ron Bjorge, Ken Froggatt (Alberta Natural Resources Service) and a number of seasonal staff conducted fieldwork and provided a wealth of information and expertise during the peregrine reintroduction program between 1991 and 1995. As well, Natural Resources Service staff at the O.S. Longman Building including Steve Brechtel, Bruce Treichel, and Gordon Court provided access to a number of files and reports. Ursula Banasch and Geoff Holroyd also provided copies of recent survey reports. Gordon Court, Steve Brechtel (Alberta Natural Resources Service), Dave Prescott (Alberta Natural Resources Service and Alberta Conservation Association) and R. Johnstone (University of Saskatchewan) reviewed the original draft and provided a number of comments that greatly improved the present document, and Jane Horb produced the maps.

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INTRODUCTION

There are at least 18 races of Peregrine Falcon (Falco peregrinus) recognized worldwide (Brown and Amadon 1989, White and Boyce 1988), three of which inhabit North America. Of these, the relatively larger and darker Peale's subspecies (F. p. pealei) occupies coastal areas of British Columbia and Alaska. The smaller and paler Tundra Peregrine Falcon (F. p. tundrius) occurs in arctic Canada and may intergrade with F. p. anatum which inhabits the interior of the continent (Brown and Amadon 1989, Johnsgard 1990; Figure 1). In Alberta, both anatum and tundrius can be seen during spring and fall migration; however only the anatum subspecies is known to breed in this province.

In the middle of this century, the anatum subspecies narrowly escaped extirpation in North America. The indiscriminate use of organochlorine pesticides after World War II had drastic effects on the reproductive success of these birds and caused a dramatic decline in numbers. The ban on the use of dichlorodiphenyl-trichloroethane (DDT) in Canada and the United States the 1970s, and three decades of intensive management, has led to the partial recovery of the subspecies (Kiff 1988). However, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) still lists the anatum Peregrine Falcon as an "endangered*" species (COSEWIC 1996). In Alberta, the anatum peregrine is listed as an "endangered animal" under the provincial Wildlife Act, and is included on the provincial "Red List" of species which are nonviable or at immediate risk of declining to nonviable levels in the province (Alberta Wildlife Management Division 1996).

* See Appendix for definitions of selected status designations

This report reviews and summarizes current information on the status of the anatum Peregrine Falcon in Alberta, as a step in reviewing the status of the (sub)species in this province.

HABITAT

In rural areas, Peregrine Falcons typically nest on cliffs close to riparian or marsh habitats. Although apparently suitable nesting sites can be found throughout the province, there has been little research directed towards quantifying specific habitat requirements of this species in Alberta. Erickson and Schmidt (1989) believed that cliffs were selected on the basis of height, aspect, protection from predators, and availability of prey. However, the broad range of sites chosen for nesting in the province makes it difficult to determine which of these factors is most important (Stepnisky 1997). For example, nest sites on the Precambrian shield of northern Alberta can be situated on outcroppings and cliffs where accessibility to humans varies from "on foot" to climbing in with ropes (Erickson and Schmidt 1989). In southern Alberta, nests are typically located on clay or sandstone cliffs along major river systems. However, birds have also returned to breed in artificial nest structures or hack boxes used for the reintroduction of captive-reared birds. In general, the basic requirement for all nesting sites is a ledge wide enough to hold a brood of up to four young, with protection from predators and inclement weather.

Although cliffs provide traditional nesting sites for Peregrine Falcons, a substantial proportion of the North American population (including Alberta) now nests on buildings and other man-made structures in urban areas. In fact, Enderson et al. (1995) estimated that in 1993 there were 87 pairs on territories in 60 cities across North America. The first pair to



Figure 1. Historical breeding range of three subspecies of the Peregrine Falcon in North America. Current populations of *F. p. anatum* are locally distributed within the indicated range.

nest in southern Alberta during the "post-DDT" era was found on the AGT Toll building in Edmonton in May of 1981 (Erickson and Court 1982). Since then, a number of pairs have chosen man-made structures for nesting sites across the province. Such sites include: high-rise buildings in downtown Edmonton, Calgary and Red Deer; industrial tower structures at Balzac and Fort Saskatchewan; and a bridge support of a train trestle in Edmonton.

During migration, anatum peregrines from Alberta, as well as both anatum and tundrius peregrines from the Northwest Territories, Yukon and Alaska, frequent large water bodies such as Beaverhill Lake (Dekker 1980, 1987) where migrating prey, such as shorebirds and waterfowl, are readily available. On their wintering grounds, anatum peregrines appear to prefer coastal habitats (Schmutz et al. 1991), again, likely because of the presence of abundant prey.

CONSERVATION BIOLOGY

Peregrine Falcons arrive on the breeding grounds in Alberta around mid-April, although the exact timing varies in different areas and for different pairs. In Edmonton, Folinsbee (1995) records 15, 16, and 19 April as average arrival dates for three different pairs in that city between 1981 and 1994, with the earliest arrival being 6 April. Similar arrival dates were noted for all pairs in the southern Alberta population during 1996, with the earliest arrival being 21 March (Stepnisky unpubl. data). The remote nature of nest sites in northern Alberta makes it difficult to determine the exact arrival dates of falcons in that area. However, documentation of occupancy rates during repeat visits to nests by biologists during the breeding seasons of 1987 to 1994 suggests that approximately 40% of falcon territories are occupied by 9 to

19 April, 80% are occupied by 19 to 29 April, and 90% are occupied by 29 April to 9 May (G. Holroyd, pers. comm.).

Once on territory, a pair will carry out courtship rituals (mutual roosting, cooperative hunting excursions, courtship flights and feedings) before copulation, nest selection, and scraping are initiated (Erickson and Schmidt 1989). Often, nests are simply a shallow scrape on a cliff ledge or building.

The average clutch size for Peregrine Falcons in southern Alberta is 3.62 eggs, with a range of one to five eggs (Stepnisky 1997). Similarly, the average clutch size in northern Alberta is 3.73 eggs, with a range of one to five eggs (Moore 1995). Eggs are usually laid at intervals of 48 hours, although there may be a gap of up to 72 hours, especially between the third and fourth eggs (Erickson and Schmidt 1989). Egg-laying occurs from the last few days in April up to the end of May, with an average laying date of 5 May for southern Alberta (calculated from 49 laying dates recorded in southern Alberta between 1981 and 1996 in Stepnisky 1996c) and an average laying date of 9 May for northern Alberta (calculated from 124 laying dates recorded in northern Alberta between 1971 and 1995 in Moore 1995). Occasionally, a second clutch will be laid in late May or early June, if the first clutch is unsuccessful.

Incubation is performed by both sexes, but most frequently by the female. Incubation starts after the last or second-last egg is laid, and synchronous hatches are the norm in Alberta (Erickson and Schmidt 1989). Pairs will often renest if they lose the first clutch within 10 to 15 days of initiating incubation. Renesting usually occurs within two weeks and is usually at an alternate nest site. Second clutches are usually smaller than the first.

The male does the majority of hunting to feed the pair while the female incubates. For the most part, the Peregrine Falcon hunts "on the wing", taking a variety of other avian species. In Alberta, prey remains collected from nest sites have been identified by Folinsbee (1995), Holroyd (in Stepnisky 1996b), and Johnston-Beaver (1979). These reports show that a wide variety of prey are eaten by Peregrine Falcons in Alberta, including grebes, gulls, small songbirds and even small rodents and insects. It is important to note that the majority of prey items recorded in these studies are of species associated with marsh habitats. This supports the contention that wetlands are an important component of habitat selection for Peregrine Falcons in Alberta.

Incubation lasts about 33 days (range of 30 to 36 days; Fyfe 1981, Nelson 1977), and hatching occurs around the middle of June in Alberta. Young birds are capable of flight at about 40 days of age, but remain dependent on adults for food for an additional 25 to 30 days (Sherrod 1983).

It is difficult to provide a reliable estimate of reproductive success for Peregrine Falcon populations in Alberta. Productivity has fluctuated in the past several decades as a direct result of contaminants affecting peregrine reproductive biology. Moreover, annual variation in clutch and brood size have been linked to climatic factors (Stepnisky et al. 1996). Although these factors make it difficult to quantify "natural" productivity levels for Peregrine Falcons in Alberta, such estimates do exist from other well-studied populations around the world. The annual average productivity of about 1.5 young per nesting pair (Newton 1979) has been accepted as the minimum reproductive standard by which most Peregrine Falcon recovery efforts in Canada are assessed (Erickson et al. 1988, Holroyd and Banasch 1996). More recent

information on adult mortality in Alberta, combined with population modeling, suggests that populations of Peregrine Falcons in the province are not sustainable unless productivity is maintained at an annual average of nearly two young per territorial pair (Court 1994, Stepnisky 1997).

Mortality of young results primarily from climatic factors (cold, wet weather), predation by Red Foxes (*Vulpes vulpes*), Golden Eagles (*Aquila chrysaetos*) and Great Horned Owls (*Bubo virginianus*), or collisions with man-made structures and vehicles when young birds first fledge (Sherrod 1983, Stepnisky 1996b).

Young Peregrine Falcons may disperse in any direction before migrating south between late August and October (Schmutz et al. 1991). In 1995, a captive-raised peregrine released in Montana was recovered several weeks later at Pakowki Lake in southern Alberta, and a young bird released near Drumheller in 1994 was recovered approximately 100 km north near Stettler that fall (Rowell 1995). Folinsbee (1995) has observed Peregrine Falcons at their nest sites in Edmonton as late as 8 October.

Peregrines mature at two or three years of age. Once mated, a pair will usually return to the same area in subsequent years, occupying a traditional nesting territory, filling a void if one member of a pair is missing, or establishing a new breeding territory if available (Erickson and Schmidt 1989). A good example of nest-site fidelity has been seen at the nest site on the AGT Toll building in Edmonton. This site has been occupied by at least one Peregrine Falcon since 1981, and has been held by the same female for 12 consecutive years (Folinsbee 1995).

Although several individual birds have returned to Alberta for 11 or 12 consecutive

years, Peregrine Falcons generally have a much shorter life span. A return rate of 10.6% for yearlings was recorded in captive release programs across Canada (Holroyd and Banasch 1990), which is similar to the rate of 12% for returning falcons from the captive release program in southern Alberta (Stepnisky 1996b). After surviving their first year, adult peregrines can face severe climatic conditions, may carry relatively high pollutant burdens, and encounter several hazards while migrating long distances twice a year. Court (1994) estimated the average annual mortality of adults in northern Alberta to be 16.4 %, and Stepnisky (1997) estimated 14% annual mortality for adult Peregrine Falcons in southern Alberta.

DISTRIBUTION

1. Alberta. - The distribution of the Peregrine Falcon has changed during the past century, mainly as a result of the dramatic reduction in the provincial population in the 1960s and a subsequent population recovery (see "Population Size and Trends" section). Prior to the 1970 National Peregrine Falcon Survey, which found only a handful of occupied peregrine nests (Cade and Fyfe 1970), the Peregrine Falcon had a widespread distribution in Alberta, and was believed to have occupied cliffs along every major river system in the province. At least 55 nesting sites are known to have been occupied in central and southern Alberta during the 1950s and 1960s (Court 1993a; Figure 2). Very few surveys were conducted in northern Alberta before 1970 and, although biologists speculate that a significant historical population of Peregrine Falcons occurred in this area (G. Court, pers. comm.), no records exist other than a few anecdotal references. For example, MacFarlane (1908) believed the Peregrine Falcon to be "fairly common" throughout northern Alberta at the turn of the century.

In the 1960s, the provincial range of the Peregrine Falcon was reduced radically. By 1970, when the first continent-wide survey was conducted in North America, Fyfe (in Cade and Fyfe 1970) reported that only three sites were known to be occupied by Peregrine Falcons in Alberta. Two of these sites were located on the Canadian Shield near Lake Athabasca in northeastern Alberta. Although one site held only a single female, the second site supported a successful pair that produced three young that year. The third site, located on the Bow River, held a productive pair until 1972. From 1973 to 1975, a single male returned to this site, but was never again accompanied by a female.

A number of random sightings in the late 1970s led to the discovery of a population in the northeast corner of the province. The five to nine pairs of breeding peregrines in this area were the subject of intensive management throughout the 1980s (Moore 1991). Continued sightings in the south (see Pinel et al. 1991) were mostly early spring and late fall observations of migrating peregrines from the arctic. Not a single breeding pair could be confirmed in all of rural southern Alberta through the 1980s, although anecdotal evidence suggests that pairs may have occupied a site since the mid-1980s on the North Saskatchewan River near Drayton Valley, and a second site on Mt. Yamnuska, west of Calgary, throughout the late 1980s (Court 1993a).

Today, after three decades of intensive management (see "Recent Management in Alberta" section), both the northern and southern sub-populations of Peregrine Falcons in Alberta are expanding. The population in the northeastern corner of the province includes pairs on the northern reaches of the Peace River and lower portion of the Slave River, on islands within the Peace-Athabasca

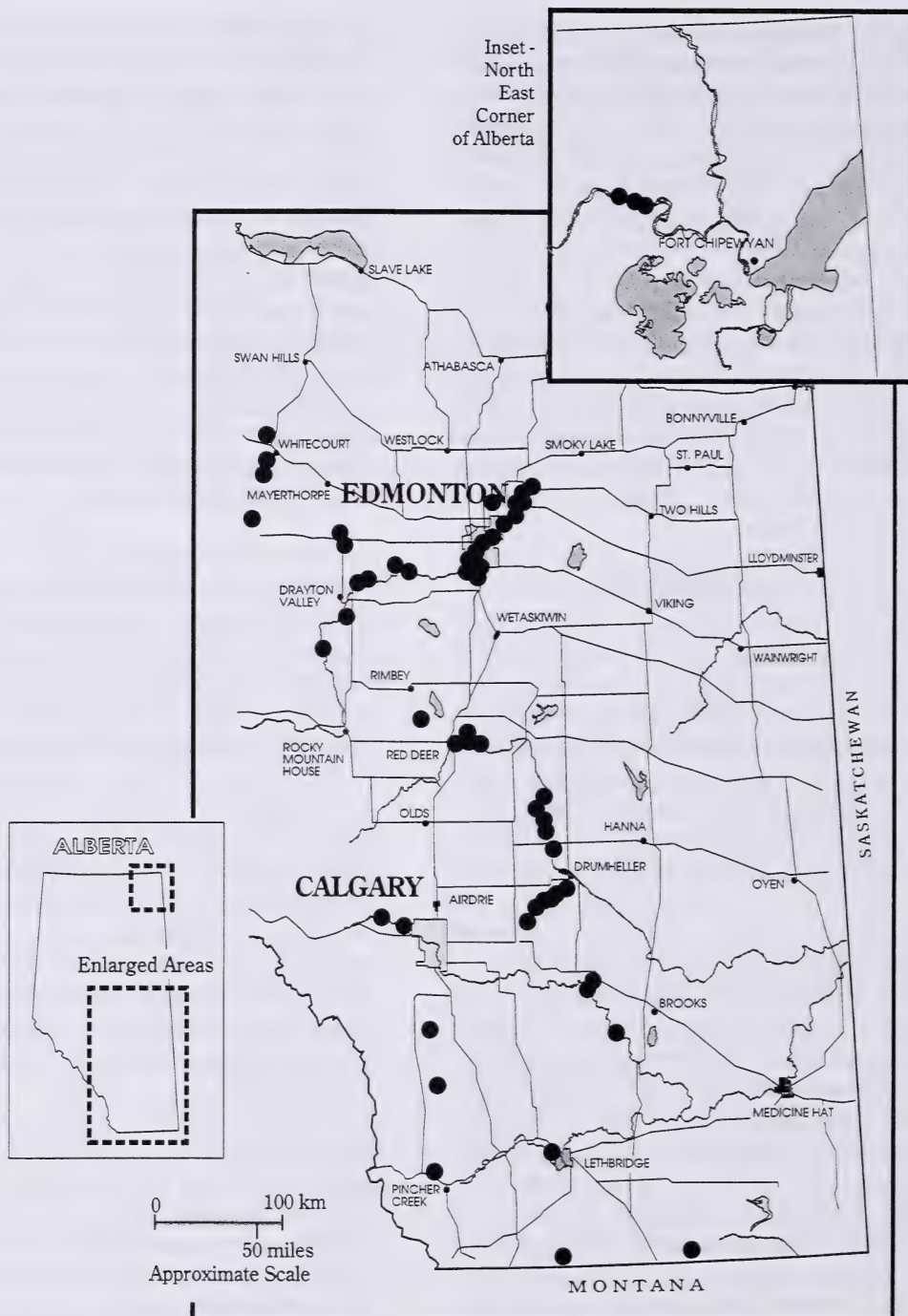


Figure 2. Peregrine Falcon nest sites that were known to be occupied prior to 1970.

delta, on the northwestern shore of Lake Athabasca, on several lakes within the western portion of the Canadian Shield, and on the limestone escarpment in and around Wood Buffalo National Park (Holroyd 1995; Figure 3). Although Holroyd surveyed the northeastern shore of Lake Athabasca in 1995, he found no breeding pairs and hypothesized that there may be inadequate prey in these areas. Limited surveys show this population does extend into the Northwest Territories and is probably the southern limit of the larger Mackenzie Valley population. This population has recovered faster than that in Alberta, and may have reached its "ecological carrying capacity" around 1990 (Shank 1995). This corresponds well with the growth seen during the past five years in the number of pairs and unbanded birds seen in northeast Alberta that are being produced by unknown pairs in the area. These individuals may represent an overflow from saturated sites further north.

In central and southern Alberta, Peregrine Falcons have returned to the North Saskatchewan, Red Deer, and Bow River drainages, but have not been recorded at historical areas on the lower Peace, Athabasca or Milk River drainages. Prey and nest sites do not appear to be limiting, however, and it should be only a matter of time before these areas are repopulated. Although the growing number of urban pairs comes as a surprise to some, cliffs along the rivers flowing through Edmonton, Red Deer and Calgary have always provided good habitat for Peregrine Falcons. That peregrines, returning to historical sites, now choose to occupy high-rise buildings only shows the adaptability of this raptor. As well, nesting pairs in urban areas are probably identified far more quickly because more observers are concentrated in urban areas. Continued search efforts in rural Alberta should lead to the discovery of more breeding peregrines in the future.

A total of 51 breeding sites (25 in the south and 36 in the north) were used by Peregrine Falcons in the province between 1970 and 1997 (Figure 3). These known breeding sites are not to be confused with the size of the Peregrine Falcon breeding in the population, as only a fraction of these sites will be occupied in any given year. For example, 72% of the 51 known sites were occupied by territorial peregrines in 1997.

2. Other Areas. - Once widespread across the continent, the anatum Peregrine Falcon was found from the interior of Alaska southwards throughout temperate North America from the California coast to the Atlantic seaboard and the Gulf of Mexico in the east. Following severe population declines, the anatum Peregrine Falcon was declared to be "extirpated" east of the Rocky Mountains and south of the boreal forest in 1975 (Fyfe et al. 1976). Today, the continental subspecies has returned, or has been reintroduced, to much of its former range including interior Alaska, the Yukon Territory (Porcupine, Peel and Yukon rivers), the Mackenzie River Valley in the Northwest Territories, the prairies (although historical and present-day records are sparse in Saskatchewan and Manitoba), southern Ontario and Quebec, Labrador, and around the Bay of Fundy. Anatum Peregrine Falcons have also repopulated the eastern, midwestern (particularly the Colorado Plateau), southwestern (California), and western (Wyoming, Montana and Idaho) United States, as well as interior and western regions of Mexico (Enderson et al. 1995, Holroyd and Banasch 1996; Figure 1).

Although the anatum subspecies is unique to North America, the Peregrine Falcon is a bird that is found on all continents of the world, with the exception of the Antarctic (White and Boyce 1988).

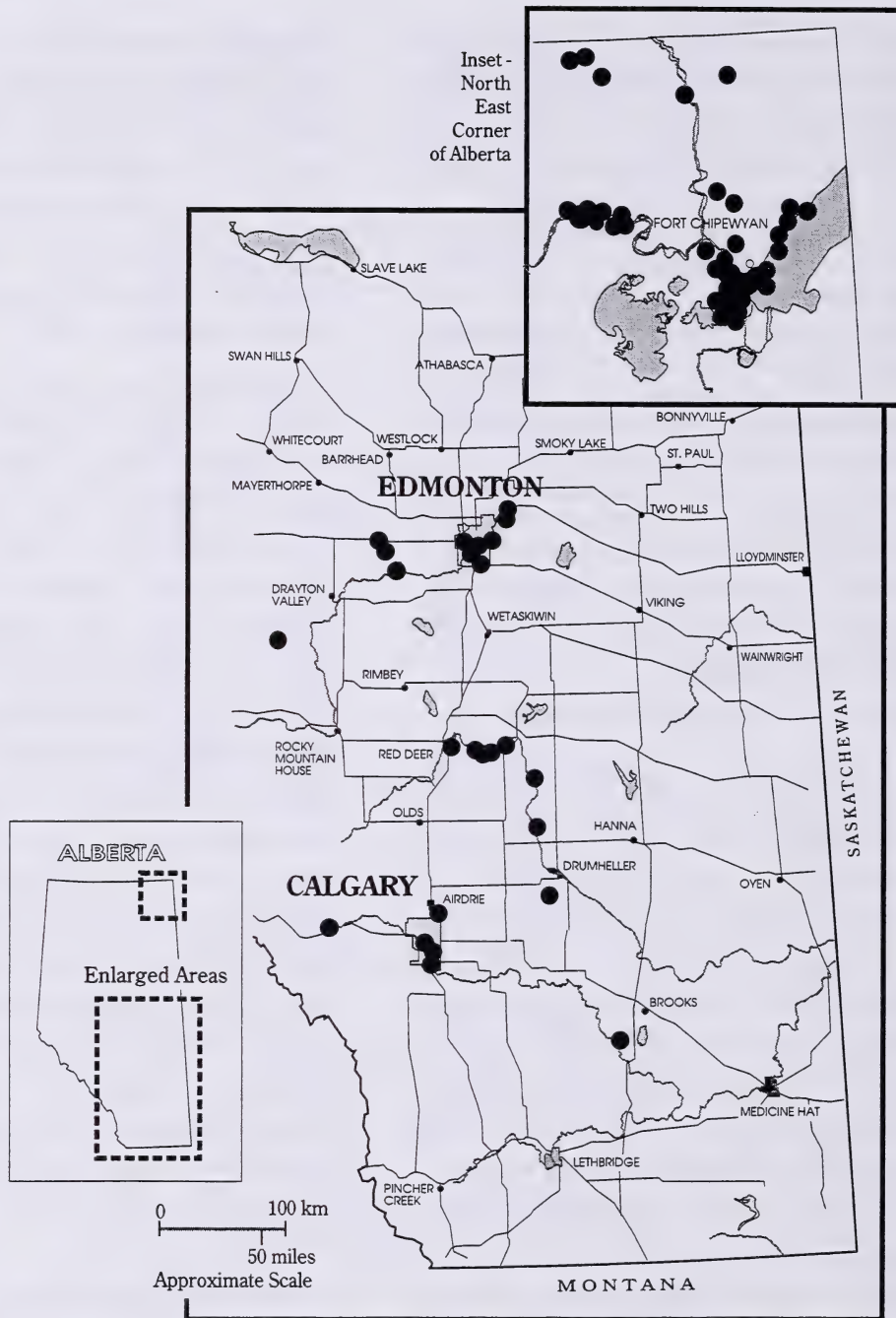


Figure 3. Peregrine Falcon nest sites known to have been occupied for at least one year between 1970 and 1997, inclusive.

Although the exact wintering range of Alberta populations of the Peregrine Falcon is not well known, band recoveries of local breeding birds, along with recoveries from other anatum Peregrine Falcons from across North America (Yates et al. 1988), suggest that individuals breeding in North America overwinter throughout South and Central America as well as the southern portions of North America. Recoveries of peregrines banded as nestlings in Alberta have come from Montana, Michigan, Illinois, Texas, Florida, Louisiana, Mexico, Belize and Columbia (Moore 1995, Stepnisky 1996c). Recent studies, using satellite tracking, indicate that Peregrine Falcons from Alaska migrate during fall in a southeasterly direction, past the Great Lakes, south to the Gulf of Mexico, and along the coast south of Mexico and Central America (Ambrose 1997). Some peregrines will cross the Caribbean, rather than follow the coast through Central America, then travel along the South American coast to winter in Brazil.

POPULATION SIZE AND TRENDS

1. Alberta. - The growth of post-DDT (1970-1997) populations of Peregrine Falcons in Alberta is well documented. Unfortunately, there is very little information regarding the populations of peregrines prior to their near extinction in the 1960s. Court (1993a) reports that a total of 55 nest sites in southern Alberta were documented as active Peregrine Falcon eyries at some time prior to 1970. This is the only pre-decline population information that exists for Alberta, and is probably an underestimate of the actual population numbers that may have existed at the turn of the century (G. Court, pers. comm.). This lack of information makes it impossible to compare present Peregrine Falcon populations with estimates of what the population size may have been before its crash in the 1960s.

Since 1970, when the first extensive survey for Peregrine Falcons was conducted in North America (Cade and Fyfe 1970), annual surveys have been conducted by federal and provincial wildlife agencies in an attempt to gain a better understanding of the falcon populations in Alberta (Fyfe et al. 1976, Holroyd and Banasch 1996, Moore 1995, Murphy 1990, Stepnisky 1996a, b, Stepnisky et al. 1996). The results of these surveys show consistently low numbers of Peregrine Falcons in Alberta up until the early 1990s, when the number of known individuals breeding in Alberta more than tripled over a five-year period (Figure 4). In 1997, after five years of extensive reintroductions, the known population of Peregrine Falcons in southern Alberta consisted of 40 territorial birds (including paired birds and singles), or 19 pairs. The population in northern Alberta consisted of 31 territorial birds (15 pairs) in 1997 (D. Moore pers. comm.). This is a remarkable recovery, considering that the known population of Peregrine Falcons in 1970 consisted of just two territorial birds in southern Alberta, and three birds in the north (Cade and Fyfe 1970).

Like the majority of Peregrine Falcon surveys that have been conducted in North America over the past several decades, changes in area surveyed, timing of the survey, time devoted to the survey, and surveyor experience have varied from year to year. This makes it difficult to compare yearly population changes with any degree of scientific accuracy (Enderson et al. 1995, Johnstone, in prep.). Although this error exists, it is probably not significant enough to mask the dramatic increase in the number of territorial Peregrine Falcons observed in Alberta over the past decade.

Without a clear understanding of the demographics of Peregrine Falcons in Alberta

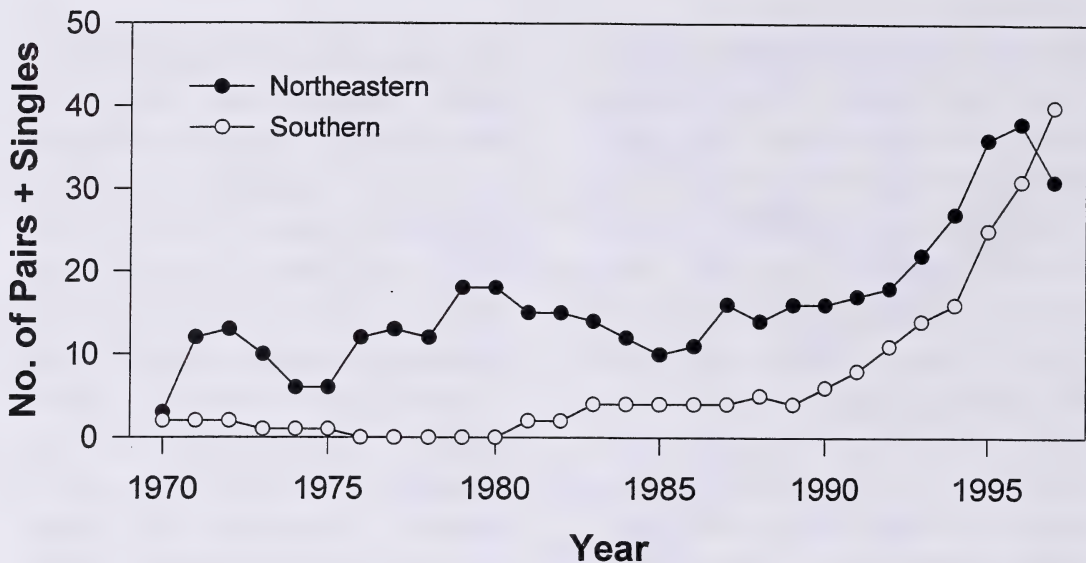


Figure 4. Known number of individual Peregrine Falcons (includes singles and members of pairs) in Alberta, 1970-1997. Data from Moore (1995), Stepnisky (1996c) and Alberta Natural Resources Service (unpubl. data).

prior to the population decline, it is necessary to look to other tools for predicting the health of the present day peregrine population. Court (1994) and Stepnisky (1997) used population modeling to determine whether the populations of falcons in Alberta are self-sustaining. Based on these predictive models, it was determined that in both the northern and southern populations, an average productivity of approximately two fledged young per territorial pair are needed to maintain a stable population. Other intensively studied populations of Peregrine Falcons in Europe have shown that production of 1 to 1.5 young per pair is adequate for increasing population size (Crick and Ratcliff 1995, Newton 1979); however these values are calculated for non-migratory populations. Peregrine Falcons in Alberta likely require higher reproductive success, as migration is thought to add a higher degree of mortality to the population. The most recent productivity data (Moore

1995, Stepnisky 1996c) shows that nests in northern Alberta average 1.7 naturally-fledged young per breeding attempt (data from 1991 to 1995; $n=68$), whereas those in the south produce an average of 1.9 fledged young per breeding attempt (data from 1992 to 1996; $n=46$). These measures of natural productivity are considerably higher than in the 1970s, when an average of about one young was fledged per breeding attempt (Moore 1991). This increase in reproductive success, and the corresponding recovery of the species in Alberta, has been directly related to decreased levels of pesticide residues found in Peregrine Falcons (see "Limiting Factors" section).

Up until 1996, "fostering" (placing of captive-raised eggs in wild nests) and "hack releases" (allowing a bird to fledge from an artificial nest structure) of captive-reared peregrines have added a substantial number of falcons to the population in Alberta (Stepnisky 1996b).

Stepnisky (1997) reported that 65% of the adults in the southern population originate from captive breeding facilities. Similarly, in the northeastern part of the province, where the fostering of young has been a major activity since 1974, 19% of the adults originate from captive breeding facilities (Figure 5). Stepnisky (1997) reported that fostering activities significantly affected the productivity at nests in southern Alberta between 1981 and 1996. With fostering, the productivity in southern Alberta averaged 2.26 young fledged per territorial pair over that time period, which is considerably greater than the 1.37 young per territorial pair reported without fostering. The impact of discontinuing release programs (see “Recent Management in Alberta” section) in 1996 is not yet clear. It is reasonable to predict that

with the increased number of adults now returning to breed in Alberta, the number of young that are naturally produced by those adult pairs will be sufficient to offset the diminished captive release efforts. The number of unbanded birds, which are presumably the offspring of unknown breeders in the area, observed in the population in recent years (Figure 5) is also encouraging. However, the number of immature one-year-olds attempting to breed indicates there remains a shortage of mature adults in this recovering population.

2. Other Areas. - Changes in the population size of Peregrine Falcons in Alberta have been mirrored, on a larger scale, across North America. It is believed that prior to the DDT era, there were approximately 7300 pairs of

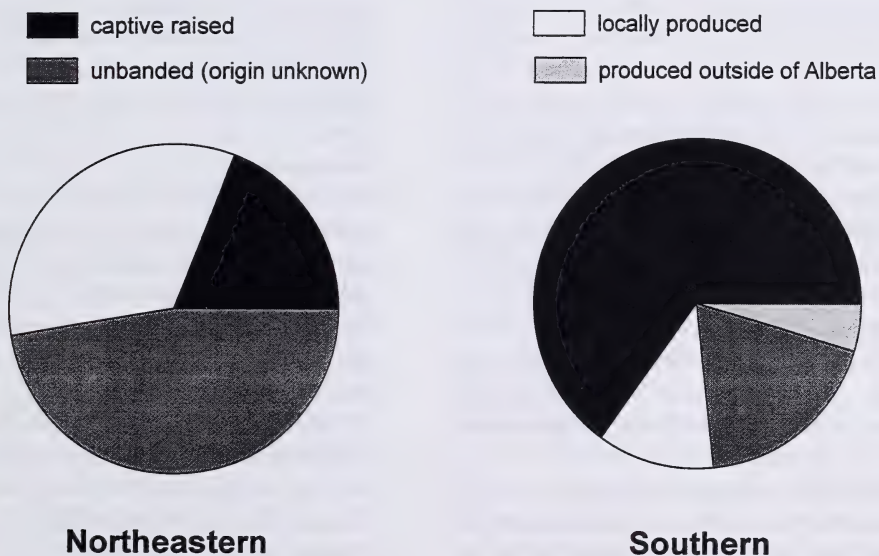


Figure 5. Origin of adult birds in Peregrine Falcon breeding populations in southern (1981-1996; n = 43) and northeastern (1977-1993; n = 57) Alberta. Captive-raised birds include young that were hack released (southern population only) or fostered to wild nests. Modified from Court (1994) and Stepnisky (1997).

Peregrine Falcons (all three subspecies), and 22,000 individuals (including non-breeders) in North America (Enderson et al. 1995). These numbers started to decline around the middle of this century, although the specific year is unclear. The first indication of reproductive failure was provided by Hall (1955), who, in 1949, observed the female of North America's first known urban-nesting pair (on the Sun Life Building in Montreal) to consume her own eggs. Observations of eggs disappearing, and deaths of embryos and chicks were subsequently reported at eyries across North America and Europe by attendees of the 1965 Madison Peregrine Conference (Hickey 1969). By this time, the Peregrine Falcon had disappeared from much of eastern North America. Over the next few years, this decline spread westward and northward, and populations reached a low in the late 1970s. By 1976, Canadian populations of *F. p. anatum* were declared to be extirpated east of the Rocky Mountains and south of the boreal forest (Fyfe et al. 1976).

The use of DDT was banned in Canada in 1969, and in the United States in 1972. After more than 20 DDT-free years, populations in the 1990s are beginning to rebound. In Canada, after releases of approximately 1500 young, the number of breeding pairs of *anatum* Peregrine Falcons is roughly 320 (Johnstone, *in prep.*). Populations of *F. p. anatum* in the Yukon and Northwest Territories have increased, and in some cases equal or exceed historical levels. Eastern populations continue to grow, as do populations in the prairies, which has been the slowest area to recover. Recovery in the eastern United States been more rapid than in the west, where releases were carried out as recently as 1996. It is estimated that over its entire range, the *anatum* peregrine has a total breeding population of over 3000 territorial pairs, with greater than 4000 fledglings

produced annually (Cade et al. *in press*, Enderson et al. 1995).

LIMITING FACTORS

Limiting factors are considered to include conditions that degrade habitat suitability, reduce survivorship of young or adults, or decrease nesting success of adults. Although, weather and predation are significant factors that affect Peregrine Falcons from year to year, the following discussion focuses on conditions linked to human activities that have long-term effects on this species.

1. Contaminant Levels. - Between 1965 and 1970, an overwhelming body of evidence was collected linking the use of chlorinated hydrocarbon pesticides, such as DDT and dieldrin, to the decline of Peregrine Falcons and other raptors (see Cade and Fyfe 1970, Peakall 1990). Whereas early population declines were attributed to direct mortality from pesticide ingestion, the production of thin-shelled eggs associated with high residue levels of DDE (a metabolite of DDT), and a corresponding increase in egg breakage and the failure of eggs to hatch, was the main cause of rapid population declines. At the second Raptor Research Planning Conference at Cornell University in 1969, attendees urged the Canadian and U.S. governments to ban the use of DDT, and to list the Peregrine Falcon as an "endangered species" (see Newton 1976). Although populations of several raptor species responded positively and rapidly to the banning of DDT in Canada (1969) and the U.S. (1972), the Peregrine Falcon population remained at very low levels.

Despite the ban on DDT more than 25 years ago, Baril et al. (1989), Court (1993b), and Court et al. (1996) indicated that there are still concerns about contaminant levels, although pesticide levels in Peregrine Falcons and their

prey are now generally below levels which interfere with reproduction. Whereas many breeding females are now able to lay and hatch their eggs successfully, both adults and the eggs they produce still carry residues of organochlorine pollutants. As well, aquatic and insectivorous species such as grebes, waterfowl, shorebirds and swallows which are common prey of falcons still contain substantial levels of contaminants (Baril et al. 1989). It is known that most contaminants of Peregrine Falcons and their prey are ingested on the wintering grounds of Central and South America, where products like DDT are still in use (Henny et al. 1982). However, prey species may transport residues to the breeding grounds where they are consumed by Peregrine Falcons. For example, Court et al. (1996) sampled a large number of dumped eggs of a single female in Alberta during 1988. Contaminant levels did not decrease with each egg laid, indicating that the bird was consuming prey on the breeding grounds that were polluted enough to have affected her reproduction.

Alberta has one of the most comprehensive records of contaminant levels in Peregrine Falcon eggs in North America, and recent trends in DDE levels found in peregrine eggs are encouraging. By diligently collecting and analyzing the contents of Peregrine Falcon eggs over time, biologists in Alberta have been able to demonstrate clearly a decreasing amount of contaminants found in Peregrine Falcons from 1965 to 1996 (Court 1993, Court et al. 1996). As expected, with the decrease of pesticide levels recorded in falcons, increases have been seen in not only the number of falcons returning to Alberta, but also in their reproductive success. Stepnisky (1997) plotted the hatching success of Peregrine Falcons over the decrease in contaminants, and found an encouraging increase in the number of eggs hatched in

recent years, when levels of contaminants were the at the lowest levels since DDT was banned (Figure 6). Although the use of organochlorine products will likely continue to decline, the risk from concentrations of these chemicals that are already with us remains.

2. Habitat Degradation/Loss. - The decline of Peregrine Falcons, unlike many other species, was not a result of habitat loss, but the direct result of contamination of the food chain. Now that contaminant levels have been reduced significantly, areas of suitable habitat should again support this species. However, as populations increase over time, suitable breeding and hunting habitat may become limiting. This will likely be more of a concern in southern Alberta, rather than in the northern population. Cliffs that have eroded and slumped, or marshes that have been drained and plowed, may no longer be available for occupancy. These factors may already be acting on other raptor species such as the Prairie Falcon (*Falco mexicanus*; Hunt 1993), although this possibility has not specifically been studied in Peregrine Falcons. Similarly, maintaining the integrity of staging, migratory and wintering habitat is equally important but unobtainable without the cooperation of several levels of jurisdiction. International agreements to make a priority of protecting wintering sites in Central and South America, where Peregrine Falcons spend up to seven months a year, must be established.

3. Human Disturbance. - Urbanization and other man-made encroachments have created some suitable nesting habitat for Peregrine Falcons, which are often found nesting on buildings and other tall structures. Such developments can have both positive and negative effects on the falcons. Peregrines have provided an excellent tool for conservationists and educators who have

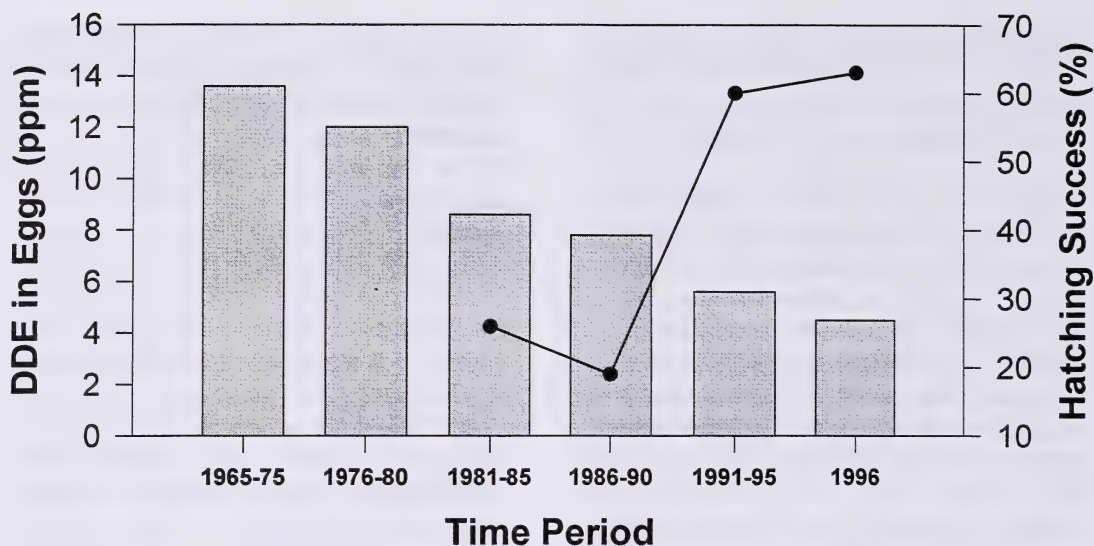


Figure 6. DDE residues in eggs (108 nest sites, 1965-1996) and hatching success (% of 217 eggs, 1981-1996) of Peregrine Falcons in Alberta (from Court 1993b, Stepnisky 1997).

cooperated with building owners and maintenance staff to maximize visibility (with audiovisual equipment) while reducing disturbance during critical nesting periods. It is often the falcons that are nesting on buildings that are most secure from predation and human disturbance at the nest site, because security and maintenance crews at those buildings enforce strict access regulations to the nest sites. The negative aspect of Peregrine Falcons nesting in populated areas is the mortality that results from collisions with vehicles and buildings and the occasional human that may harass the birds.

STATUS DESIGNATIONS

1. Alberta. - In Alberta, the Peregrine Falcon was unofficially considered to be an “endangered” species by *A Policy for the Management of Threatened Wildlife in Alberta* in 1985 (Alberta Fish and Wildlife

1985). Official recognition of “endangered” status under the Alberta Wildlife Act was made in 1987. In 1991, a review of the status of Alberta wildlife placed the anatum subspecies on the “Red List” of wildlife species which may be at, or declining to, nonviable levels in the province (Alberta Fish and Wildlife 1991). This status was assigned based on the small population size (less than 10 pairs), concern over pesticide residues, and the need for ongoing management to return populations to historical levels in the province. The “Red List” status was maintained in a similar review five years later (Alberta Wildlife Management Division 1996), when less than 50 breeding pairs were known to occur in the province.

2. Other Areas. - The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) listed the anatum Peregrine Falcon as “endangered” in 1978 (Martin 1979). At that time, there were no known

nesting pairs east of the Rocky Mountains and south of the boreal forest. After population declines of this subspecies were noted in the 1960s, the U.S. Fish and Wildlife Service listed the anatum Peregrine Falcon as "endangered" in 1970 under the Endangered Species Conservation Act of 1969, and included it in the list of "endangered" and "threatened" species under the amended Endangered Species Act of 1973.

The anatum Peregrine Falcon is currently being considered for removal from the endangered species list in the United States (Mesta et al. 1995). Although the proposal to de-list this species has stirred a great deal of controversy (Pagel et al. 1996), many government agencies and conservation organizations support the move (G. Court, pers. comm.). A similar move to review the status of the Peregrine Falcon in Canada has just begun. In an updated status report for COSEWIC on the anatum Peregrine Falcon in Canada, Johnstone (in prep.) recommends that the Peregrine Falcon be reclassified as "vulnerable" in Canada. This recommendation will be reviewed by the COSEWIC committee in the near future.

RECENT MANAGEMENT IN ALBERTA

Coordinated efforts to reverse the decline of Peregrine Falcons began in 1970 (Fyfe 1976). In that year, delegates at the federal-provincial wildlife conference agreed that the Canadian Wildlife Service (CWS) would establish a Peregrine Falcon breeding project, with the goal of establishing several captive breeding pairs, and eventually reintroducing offspring within their former range once pesticide levels had fallen to acceptable levels (see Fyfe 1976). Twelve anatum Peregrine Falcons were collected from several different areas in 1970, including Lake Athabasca, the North

Saskatchewan River, and the Bow River. These birds were housed at the farm of Richard Fyfe near Edmonton until a breeding facility was built at Canadian Forces Base Wainwright in the winter of 1972-73. Similar facilities were built at Black Diamond, and at Saskatoon, Saskatchewan and Ste. Anne de Bellevue, Quebec.

Captive Peregrine Falcons at the Wainwright facility produced their first fertile eggs in 1973. In 1974, CWS, in partnership with Parks Canada (Wood Buffalo National Park) and Alberta Fish and Wildlife began manipulating a small remnant population near Fort Chipewyan in order to augment the captive gene pool and to maximize production of the remaining wild population. A technique called "double-clutching", where a clutch is removed in order to induce the breeding pair to produce a second clutch, was used to increase egg production. Six young were subsequently produced from two breeding pairs that year. In 1975, the Wainwright facility paired 10 captive peregrines that produced 26 fertile eggs and 17 young. Six of these young were successfully placed as foster chicks in wild nests in northern Alberta in exchange for three naturally produced young that were brought into the captive-breeding program that year.

Although the 1970s saw tremendous achievements made in captive breeding, wild populations continued to dwindle. With the breeding facility now able to produce an excess of young peregrines, active fostering of young to wild pairs unable to produce a full complement of four young on their own became standard management practice. As well, hack releases were initiated in 1976 as a method of fledging young without adult birds being present. Releases using this method were conducted in Edmonton from 1976 to 1981, in Fort Saskatchewan from 1976 to

1977, in Black Diamond from 1976 to 1978 (Lukey 1978), in Kananaskis Country from 1979 to 1982 (Davie et al. 1981, Nelson and Bauer 1980, Wisely 1983, Wisely and Bauer 1982, Wisely and Davie 1987), on the Red Deer River at Ardley from 1981 to 1985 (Kinsella 1985a, Lang 1984a, Verbeurght 1983a,b), and on the Rosebud River from 1982 to 1985 (Kinsella 1985b, Lang 1983, 1984b, Verbeurght 1983c).

Between 1975 and 1985, approximately 250 captive-raised young were released in Alberta. Several of these young returned to breed (Moore 1995), however, return rates in general were poor. Moore (1995) documented that only 37 of 413 birds banded between 1975 and 1985 (either captive-raised or wild young of known breeding pairs) were encountered at least one year after fledging. This rate (9%), though likely an underestimate, is slightly lower than the 10.6% return rate for all Canadian releases cited by Holroyd and Banasch (1990). Although, factors such as a long migration, human disturbance, and predation probably contributed to Alberta's low return rate of released falcons, high pesticide levels in peregrines and their prey were still believed to be the factor that most influenced survivorship and reproduction throughout the 1980s.

In 1988, the National Peregrine Falcon Recovery Team formulated a plan that outlined the steps required to reintroduce and/or increase populations of *F. p. anatum* across Canada (Erickson et al. 1988). The plan's objectives were to establish by 1992 a minimum of 10 territorial pairs in each of six zones (with most of Alberta being included in the prairie zone except the very northern area that was included in the Mackenzie zone). These pairs were expected to fledge 15 or more young annually, measured as a five-year average commencing in 1993. Similar goals

were also stated in the *Northern Alberta Peregrine Falcon Management Plan* (Erickson and Schmidt 1989) and in the *Draft Management Plan for the Peregrine Falcon in Alberta* (Paetkau 1990). In these documents, Alberta managers sought to protect the present population (in northeastern Alberta) from further decline, to increase the number of breeding pairs throughout the province using reintroductions, and to determine the factors regulating populations. The overall goal was to enhance the population to the point where it would no longer be endangered.

All release programs, aside from fostering to existing pairs, were effectively stalled between 1986 to 1991 because of concerns about the effectiveness of the program, and because of continuing high levels of pesticide residues in Alberta Peregrine Falcons (Court 1993b, Court et al. 1996). However, a number of factors emerged in the late 1980s that suggested reintroduction might again be a valid management option. Most important of these factors was that pesticide residue levels in primary prey and peregrine eggs declined significantly in Alberta (Court 1993b, Court et al. 1996). With this decline came a corresponding increase in eggshell thickness that allowed "Arrow", one of Alberta's best known urban falcons, to incubate and successfully hatch her own eggs in 1992, after being a relatively unsuccessful breeder and the subject of fostering programs for 11 years. Other female falcons in western North America showed similar improvements in breeding success.

These encouraging developments spurred a period of renewed activity in the management of Peregrine Falcons in Alberta in the early 1990s. After preliminary work in 1991, the Peregrine Falcon Management Team composed of representatives from Alberta Natural Resources Service, Canadian Wildlife

Service and project sponsor, Petro-Canada, initiated a five-year release program in 1992 in southern Alberta. This project saw the release of 223 falcons along the Bow and Red Deer rivers. The program has achieved its main goal of having 10 breeding pairs producing 15 natural young per year in southern Alberta, well before the last cohort of fledglings released in 1996 have returned to breed (Stepnisky 1997). Over the same time period, the continued fostering of captive-raised young and extensive surveying in the north (including adjacent parts of the Northwest Territories) led to the increase of that population to the desired level of approximately 20 pairs (23 in 1995).

With the closing of the Wainwright breeding facility in 1996, future management strategies in Alberta will focus on fostering captive-raised chicks (from other breeding facilities) to new, inexperienced pairs, protecting nesting and feeding habitat, educational programs centered on urban pairs, and monitoring breeding numbers and productivity.

SYNTHESIS

The Peregrine Falcon is a widely distributed but uncommon species in Alberta. The total number of known breeding pairs is presently less than 40, although this is likely an underestimate. Whereas populations across

North America have been on the increase since the 1980s, recovery in Alberta has only seen significant gains in the past five years. Although the number of breeding pairs in Alberta has increased, early efforts at population modeling suggest that low productivity may still be a factor affecting the growth of this population (Court 1994, Stepnisky 1997). As well, a significant proportion of both the northeastern and southern populations consists of captive-raised young. The termination of breeding and mass-release programs in 1996 should result in a lower proportion of captive-reared birds in the population in future years, but the impacts of this change on the growth of provincial populations is currently not clear.

Although the Peregrine Falcon is a tenacious and adaptable species that shows all signs of a recovery now that the primary factor affecting its decline has been removed, continued monitoring and surveying of provincial populations is necessary to ensure that the recovery continues. Such studies should include documenting occupancy rates of known nest sites, searches for new nesting areas, and the banding of birds and determination of population composition (wild versus released birds). This will help determine whether intensive human intervention must continue if the provincial population is to increase to historical levels.

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APPENDIX . Definitions of selected legal and protective designations.

A. Status of Alberta Wildlife color lists (after Alberta Wildlife Management Division 1996)

Red	Current knowledge suggests that these species <u>are</u> at risk. These species have declined, or are in immediate danger of declining, to nonviable population size
Blue	Current knowledge suggests that these species <u>may be</u> at risk. These species have undergone non-cyclical declines in population or habitat, or reductions in provincial distribution
Yellow	Species that are not currently at risk, but may require special management to address concerns related to naturally low populations, limited provincial distributions, or demographic/life history features that make them vulnerable to <u>human-related</u> changes in the environment
Green	Species not considered to be at risk. Populations are stable and key habitats are generally secure
Undetermined	Species not known to be at risk, but insufficient information is available to determine status

B. Alberta Wildlife Act

Species designated as “endangered” under the Alberta Wildlife Act include those defined as “endangered” or “threatened” by *A Policy for the Management of Threatened Wildlife in Alberta* (Alberta Fish and Wildlife 1985):

Endangered	A species whose present existence in Alberta is in danger of extinction within the next decade
Threatened	A species that is likely to become endangered if the factors causing its vulnerability are not reversed

C. Committee on the Status of Endangered Wildlife in Canada (after COSEWIC 1996)

Extirpated	A species no longer existing in the wild in Canada, but occurring elsewhere
Endangered	A species facing imminent extirpation or extinction
Threatened	A species likely to become endangered if limiting factors are not reversed
Vulnerable	A species of special concern because of characteristics that make it particularly sensitive to human activities or natural events
Not at Risk	A species that has been evaluated and found to be not at risk
Indeterminate	A species for which there is insufficient scientific information to support status designation

D. United States Endangered Species Act (after National Research Council 1995)

Endangered	Any species which is in danger of extinction throughout all or a significant portion of its range
Threatened	Any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range

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NOTES

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1. *Journal of the Royal Microscopical Society*, 1910, 30, 1-10.
2. *Journal of the Royal Microscopical Society*, 1910, 30, 11-20.
3. *Journal of the Royal Microscopical Society*, 1910, 30, 21-30.
4. *Journal of the Royal Microscopical Society*, 1910, 30, 31-40.
5. *Journal of the Royal Microscopical Society*, 1910, 30, 41-50.
6. *Journal of the Royal Microscopical Society*, 1910, 30, 51-60.
7. *Journal of the Royal Microscopical Society*, 1910, 30, 61-70.
8. *Journal of the Royal Microscopical Society*, 1910, 30, 71-80.
9. *Journal of the Royal Microscopical Society*, 1910, 30, 81-90.
10. *Journal of the Royal Microscopical Society*, 1910, 30, 91-100.

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